Diploma Program Biology Internal Assessment

Internal assessment (IA) is an integral part of the course and is compulsory for both SL and HL students. It enables students to demonstrate the application of their skills and knowledge, and to pursue their personal interests, without the time limitations and other constraints that are associated with written examinations.

It is recommended that a total of **10 hours of teaching time** should be allocated to the work. This should include:

- Time for the teacher to explain to the students the requirements of the internal assessment
- Class time for students to work on the internal assessment component and to ask questions
- Time for consultation between the teacher and each student
- Time to review and monitor progress and to check authenticity

The internal assessment is **worth 20% of the final assessment** and consists of one scientific investigation. The individual investigation should cover a topic that is commensurate with the level of the course of study. The internal assessment task will be one scientific investigation taking about 10 hours and **the write-up should be about 6-12 pages long**. *Investigations exceeding this length will be penalized in the communication criterion as lacking in conciseness.*

Some of the possible tasks include:

- a hands-on laboratory investigation
- using a spreadsheet for analysis and modeling
- extracting data from a database and analyzing it graphically
- producing a hybrid of spreadsheet/database work with a traditional hands-on investigation
- using a simulation, provided it is interactive and open-ended

Internal Assessment Criteria
The assessment model uses 5 criteria to assess the final report of the individual investigation.

Personal Engagement	Exploration	Analysis	Evaluation	Communication	Total
0-2 (8%)	0-6 (25%)	0-6 (25%)	0-6 (25%)	0-4 (17%)	0-24 (100%)

Levels of performance are described using multiple indicators per level. In many cases, the indicators occur together in a specific level, but not always. Also, not all indicators are always present. This means that a candidate can demonstrate performances that fit into different levels.

Personal Engagement (0-2; 8%)
This criterion assesses the extent to which the student engages with the exploration and makes it their own. Ways to demonstrate this criterion could include:

- Addressing personal interests
- Showing evidence of independent thinking, creativity, or initiative in the designing, implementation, or presentation of the investigation.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1	*** The evidence of personal engagement with the exploration is limited with little independent thinking, initiative, or creativity.** * The justification given for choosing the research question and/or the topic under investigation does not demonstrate **personal significance, interest, or curiosity.** * There is little evidence of **personal input and intiative** in the designing, implementation, or presentation of the investigation.
2	*** The evidence of personal engagement with the exploration is clear with significant independent thinking, initiative, or creativity.** * The justification given for choosing the research question and/or the topic under investigation demonstrates **personal significance, interest or curiosity.** * There is evidence of **personal input and initiative** in the designing, implementation, or presentation of the investigation.

The investigation **does not have to be ground-breaking research, but there should be an indication that independent thought has been put into the choice of topic, the method of inquiry and the presentation of the findings**. The topic chosen should also be of suitable complexity. If the research question is very basic or the answer self-evident then there is little opportunity to gain full marks for exploration and analysis as the student will not have the opportunity to demonstrate his or her skills.

Exploration (0-6; 25%)
This criterion assesses the extent to which the student establishes the scientific context for the work, states a clear and focused research question and uses concepts and techniques appropriate to the DP level. Where appropriate, this criterion also assesses awareness of safety, environmental, and ethical considerations.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1-2	* The topic of the investigation is identified and a research question of some relevance is **stated but it is not focused.** * The background information provided for the investigation is **superficial** or of limited relevance and does not aid the understanding of the context of the investigation. * The methodology of the investigation is only appropriate to address the research question to a very limited extent since it takes into consideration few of the significant factors that may influence the relevance, reliability, and sufficiency of the collected data. * The report shows evidence of limited awarenets of the significant **safety**, ethical or environmental issues that are **relevant to the methodology of the investigation.**
3-4	* The topic of the investigation is identified and a relevant but not fully focused research question is described. * The background information provided for the investigation is mainly appropriate and relevant and aids the understanding of the context of the investigation. * The methodology of the investigation is mainly appropriate to address the research question but has limitations since it takes into consideration only some of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. * The report shows evidence of some awareness of the significant **safety** , ethical or environmental issues that are **relevant to the methodology of the investigation.**
5-6	* The topic of the investigation is identified and a relevant and fully focused research question is clearly described. * The background information provided for the investigation is entirely appropriate and relevant and enhances the understanding of the context of the investigation. * The methodology of the investigation is highly appropriate to address the research question because it takes into consideration all, or nearly all, of the significant factors that may influence the relevance, reliability and sufficiency of the collected data. * The report shows evidence of full awareness of the significant **safety**, ethical or environmental issues that are **relevant to the methodology of the investigation.**

Take your individual ideas and translate them into a workable method. You need to demonstrate the thinking behind your ideas using your subject knowledge. Center your information around the problem. Give the necessary details of the method in terms of variables, controls and the nature of the data that is to be generated. This data must be of sufficient quantity and treatable in an appropriate manner, so that it can generate a conclusion, in order to fulfill the criteria of analysis and evaluation.

* Health and safety is a key consideration in experimental work. Be sure to take this into account when writing your method. Full evidence and awareness is when all potential hazards have been identified, with a brief outline given as to how they will be addressed. This includes working with animals, tissue, and chemicals.

Analysis (0-6; 25%)

This criterion assesses the extent to which the student's report provides evidence that the student has selected, recorded, processed, and interpreted the data in ways that are relevant to the research question and can support a conclusion.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1-2	* The report includes **insufficient relevant** data to support a valid conclusion to the research question. * Some **basic** data processing is carried out but is either too **inaccurate or too insufficient to lead to a valid** conclusion. * The report shows evidence of little consideration of the impact of measurement uncertainty on the analysis. * The processed data is incorrectly or insufficiently interpreted so that the conclusion is invalid or very incomplete.
3-4	* The report includes relevant but incomplete quantitative and qualitative raw data that could support a simple or partially valid conclusion to the research question. * Appropriate and sufficient data processing is carried out that could lead to a broadly valid conclusion but there are significant inaccuracies and inconsistencies in the processing. * The report shows evidence of some consideration of the impact of measurement uncertainty on the analysis. * The processed data is interpreted so that a broadly valid but incomplete or limited conclusion to the research question can be deduced.
5-6	* The report includes sufficient relevant quantitative and qualitative raw data that could support a detained and valid conclusion to the research question. * Appropriate and sufficient data processing is carried out with **the accuracy** required to enable a conclusion to the research question to be drawn that is fully **consistent** with the experimental data. * The report shows evidence of full and appropriate consideration of the impact of measurement uncertainty on the analysis. * The processed data is correctly interpreted so that a completely valid and detailed conclusion to the research question can be deduced.

This section deals with the data generated and how it is processed. There must be sufficient data (e.g. 5x5). All treatment of the data should be appropriate to the focus of your investigation in an attempt to answer the research question. All conclusions drawn should be based on evidence, not assumptions. There needs to be appropriate presentation of data and statistical analysis should be conducted to determine significance of data. Conclusions should be stating correlations of data (e.g. *x* has a positive correlation with *y).*

Evaluation (0-6; 25%)

This criterion assesses the extent to which the student's report provides evidence of evaluation of the investigation and the results with regard to the research question and the accepted scientific context.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1-2	* A conclusion is **outlined** which is not relevant to the research question or is not supported by the data presented. * The conclusion makes superficial comparison to the accepted scientific context. * Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **outlined** but are restricted to an **account** of **the practical** or **procedural issues** faced. * The student has **outlined** very few realistic and relevant suggestions for the improvement and extension of the investigation.
3-4	* A conclusion is **described** which is relevant to the research question and supported by the data presented. * A conclusion is described which makes some relevant comparison to the accepted scientific context. * Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **described** and provide evidence of some awareness of the **methodological issues** involved in establishing the conclusion. * The student has **described** some realistic and relevant suggestions for the improvement and extension of the investigation.
5-6	* A detailed conclusion is **described and justified** which is entirely relevant to the research question and fully supported by the data presented. * A conclusion is correctly **described and justified** through relevant comparison to the accepted scientific context. * Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **discussed** and provide evidence of a clear understanding of the **methodological issues** involved in establishing the conclusion. * The student has **discussed** realistic and relevant suggestions for the improvement and extension of the investigation.

This area is reserved for the connections of conclusions made in the Analysis to the context of the original aim and research question. For instance, does the conclusion support the student's original thinking in the topic? If not, a consideration of why it does not will lead into an evaluation of the limitations of the method and suggestions as to how the method and approach could be adjusted to generate data that could help draw a firmer conclusion. Variability of the data may well be mentioned again in the evaluation as this provides evidence for the reliability of the conclusion.

Communication (0-4; 17%)
This criterion assesses whether the investigation is presented and reported in a way that supports effective communication of the focus, process and outcomes.

Mark	Descriptors
0	The student's report does not reach a standard described by the descriptors below.
1-2	*** The presentation of the investigation is unclear, making it difficult to understand the focus, process and outcomes.** * The report is not well structured and is unclear: the necessary information on focus, process and outcomes is missing or is presented in an incoherent or disorganized way. * The understanding of the focus, process and outcomes of the investigation is obscured by the presence of inappropriate or irrelevant information. * There are many errors in the use of subject-specific terminology and conventions.
3-4	**The presentation of the investigation is clear. Any errors do not hamper understanding of the focus, process and outcomes.** * The report is well structured and clear: the necessary information on focus, process and outcomes is present and presented in a coherent way. * The report is relevant and concise, thereby facilitating a ready understanding of the focus, process and outcomes of the investigation. * The use of subject-specific terminology and conventions is appropriate and correct. Any errors do not hamper understanding.

This section takes the entire write-up into consideration. If the report is clearly written and logically presented there should be no need for the teacher to re-read it. The report should be focused. Avoid extraneous information. The vocabulary should be subject-specific and of a quality appropriate to diploma level.

- Correct formats for graphs, tables, and cell headings
- Correct use of units and the recording of errors
- Minor errors are acceptable as long as they do not have a significant bearing on understanding or the interpretation of the results

Rationale for practical work

Although the requirements for IA are centered on the investigation, the different types of practical activities that a student may engage and serve other purposes, including:

- Illustrating, teaching and reinforcing theoretical concepts
- Developing an appreciation of the essential hands-on nature of much scientific work
- Developing an appreciation of scientists' use of secondary data from databases
- Developing an appreciation of scientists' use of modeling
- Developing an appreciation of the benefits and limitations of scientific methodology

Data Presentation in DP Biology

Units

- Use International System of Units (SI) wherever possible (Metric system)
- Units should be fit for purpose

Tables

- Tables are designed to lay out the data ready for analysis
- Table should have an explanatory table.
  * 'Table of results is NOT explanatory
  * 'Table to show the time taken to produce 1 cm^3 of oxygen at different concentrations of carbon dioxide by *Elodea*' IS explanatory.
  * Units ONLY in cell headings, rather than in the body of the table.
  * Error for the instrument used or the accuracy of the reading should appear in the cell heading, if relevant.
  * The independent variable should be in the first column.
  * Subsequent columns should show the results for the dependent variable.
  * Decimal places should be consistent throughout a column.
  * Mean values should not have more decimal places than the raw data used to produce them.
  * The methods used to process the data should be easy to follow and the processed data may be included in the same table as the raw data, there is no need to separate them.

Graphs

- Clear, easy to read and interpret with an explanatory title
- If IT software is used (e.g. Microsoft Excel), the graph should have clearly identifiable data points and demarcated and labeled axes of a suitable scale
- Adjacent data points should be joined by a straight line
- Line should start with the first data point and end with the last one- No extrapolation
- Lines of best fit are ONLY useful if there is good reason to believe that intermediate points fall on the line between 2 data points
- Type of graph chosen should be appropriate to the nature of the data collected

Error

There are sources of error at a number of stages of any investigation. Your chosen method should try to address as many as possible by considering the control of variables, but despite this, many will remain. A **thorough** evaluation of the sources of uncertainty and error will also help to gain perspective on the investigation in general and to suggest potential improvements and extensions.

Random variation and normal variation

e.g. The water potential of potato tissue may be calculated by soaking pieces of tissue in a range of concentrations of sucrose solution. The pieces of tissue may vary in their water potential, especially if they are taken from different potatoes. Pieces of tissue taken from the same potato will also show variations in water potential, but they will probably show a normal variation that is less than that from samples taken from different potatoes.

* Random errors can, therefore be kept to a minimum by careful selection of material and by **careful control of variables.**

Human errors

Making mistakes is not an acceptable source of error if they could have been easily avoided with more due care and attention. Careful planning is a must!

The act of measuring

- A cold thermometer can influence the temperature of a small amount of liquid in a thermometer
- A human observer can influence the behavior of an animal
- Be sure to take these possibilities into account

Degrees of precision and uncertainty in data

- Choose an appropriate instrument for measurement! You do not need to justify each choice
- For degrees of precision, the simplest rule is that the degree of precision is plus or minus (+/-) the smallest division on the instrument. This is true for rulers and instruments with digital displays.
  e.g. A ruler value of 15.6 cm would become 15.60 (+/- 0.05 cm). Note that the length value is now cited to one extra decimal place so as to be consistent with the uncertainty.
- No specific overall protocol for uncertainty calculation is preferred- as long as it is clear that recording of uncertainties has been undertaken and the uncertainties are of a sensible and consistent magnitude.

Propagating errors

Propagating errors during data processing is not expected but it is accepted provided the basis of the experimental error is explained.

Replicates and Samples

Rule of thumb- the **lower** limit is 5 measurements within the independent variable, with 3 runs for each

- To reduce standard deviation, strive for 5 runs
- Standard deviation should be calculated
- Error bars- Can plot the highest and lowest value for a test. A more effective presentation will use the standard deviation for error bars.

Statistics

- Statistics will help to assess the nature of a trend and whether it is significant
- Briefly explain your choice of test (chi-square, t-test, ANOVA, etc.)
- Correct protocol should be presented, including null & alternative hypotheses, degrees of freedom, critical values and probability levels